

## Dam Safety: Embankment Instabilities

The dam embankment and any appurtenant dikes must safely contain the reservoir during normal and flood conditions. Cracks, slides, and depressions are signs of embankment instability and should indicate to the owner that maintenance or repair work may be required.



Figure 1 – Beaching

When one of these conditions is detected, the owner must retain a qualified dam safety professional to determine the cause of the instability. A rapidly changing condition or the sudden development of a large crack, slide, or depression indicates a very serious problem, and the IDNR-Division of Water should be contacted immediately. A qualified dam safety professional must investigate these types of embankment stability problems because a so-called “home remedy” may cause greater and more serious damage to the embankment and eventually result in unneeded expenditures for unsuccessful repairs.

### Cracks

Short, isolated cracks are commonly due to drying and shrinkage of the embankment surface and are not usually significant. They are usually less than 1 inch wide, propagate in various directions, and occur especially where the embankment lacks a healthy grass cover. Larger (wider than 1 inch), well-defined cracks may indicate a more

serious problem. There are generally two types of these cracks: longitudinal and transverse. Longitudinal cracks extend parallel to the crest of the embankment and may indicate the early stages of a slide on either the upstream or downstream slope of the embankment. They can create problems by allowing runoff to enter the cracks and saturate the embankment which in turn can cause instability of the embankment. Transverse cracks extend perpendicular to the crest and can indicate differential settlement within the embankment. Such cracks provide avenues for seepage through the dam and could quickly lead to piping, a severe seepage problem that will likely cause the dam to fail.

If the owner finds small cracks during inspection of the dam, he/she should document the observations, and seal the cracks to prevent runoff from saturating the embankment. The documentation should consist of detailed notes (including the location, length, approximate elevation, and crack width), photographs, sketches, and possibly monitoring stakes. The crack must then be monitored during future inspections. If the crack becomes longer or wider, a more serious problem, such as a slide, may be developing. Large cracks indicate serious stability problems. If one is detected, the owner should contact the Dam and Levees Section and/or retain an engineer to investigate the crack and prepare plans and specifications for repairs. When muddy flow discharges from a crack, the dam may be close to failure. The emergency action plan should be initiated immediately and the IDNR-Division of Water contacted.

### Slides

A slide in an embankment or in natural soil or rock is a mass movement of material. Some typical characteristics of a slide are an arc-shaped crack or scarp along the top and a bulge along the bottom of the slide (see drawing). Slides may develop because of poor soil compaction, the gradient of the slope being too steep for the embankment material, seepage, sudden

drawdown of the lake level, undercutting of the embankment toe, or saturation and weakening of

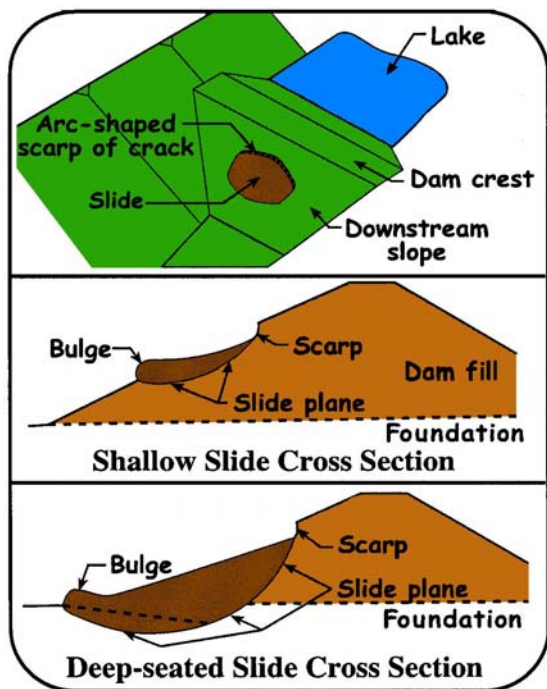


Figure 2 – Slide cross-sections

the embankment or foundation.

Slides can be divided into two main groups: shallow and deep-seated. Shallow slides generally affect the top 2 to 3 feet of the embankment surface. Shallow slides are generally not threatening to the immediate safety of the dam and often result from wave erosion, collapsed rodent burrows, or saturated top soil. Deep-seated slides are serious, immediate threats to the safety of a dam. They can extend several feet below the surface of the embankment, even below the foundation. A massive slide can initiate the catastrophic failure of a dam. Deep-seated slides are the result of serious problems within the embankment.

Small slides can be repaired by removing the vegetation and any unsuitable fill from the area, compacting suitable fill and adding topsoil to make the embankment uniform, and establishing a healthy grass cover. If a shallow or deep-seated slide is discovered, the IDNR-Division of Water should be contacted and an engineer retained to investigate the slide. Plans and specifications may need to be prepared for its repair depending on the findings of the investigation.

## Depressions

Depressions are sunken areas of the abutment, toe area, or embankment surface. They may be created during construction, or may be caused by decay of buried organic materials, thawing of frozen embankment material, internal erosion of the embankment, or settlement (consolidation) of the embankment or its foundation. To a certain degree, minor depressions are common and do not necessarily indicate a serious problem. (An embankment with several minor depressions may be described as “hummocky”.) However, larger depressions may indicate serious problems such as weak foundation materials, poor compaction of the embankment during construction, or internal erosion of the embankment fill.

Depressions can create low areas along the crest, cracks through the embankment, structural damage to spillways or other appurtenant structures, damage to internal drainage systems, or general instability of the embankment. They can also inhibit maintenance of the dam and make detection of stability or seepage problems difficult.

The owner should monitor depressions during the regular inspection of the dam. All observations should be documented with detailed notes, photographs, and sketches. Minor depressions can be repaired by removing the vegetation and any unsuitable fill from the area, adding fill and then topsoil to make the embankment uniform, and finally establishing a healthy grass cover. An engineer should be retained to investigate large depressions or settlement areas. Plans and specifications may need to be prepared for its repair depending on the findings of the investigation.

## Importance of Inspection

Stability problems can threaten the safety of the dam and the safety of people and property downstream. Therefore, stability problems must be detected and repaired in a timely manner. The entire embankment should be routinely and closely inspected for cracks, slides, and depressions. To do this thoroughly, proper vegetation must be regularly maintained on the embankment. Improper or overgrown vegetation can inhibit visual inspection and maintenance of the dam. Accurate inspection records are also needed to detect stability problems. These records can help determine if a condition is new, slowly changing, or rapidly changing. A rapidly changing condition or the sudden development of

a large crack, slide, or depression indicates a very serious problem, and the IDNR-Division of Water must be contacted immediately.

Any questions, comments, concerns, or fact sheet requests should be directed to the Division of Water at the following address:

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